BASIC CHARACTERISTICS OF GEOLOGICAL "MEGASINCLINORIUM" STRUCTURE OF MIRDITA ZONE

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ABSTRACT

The basic characteristics of the Mirdita Zone structure are in the present paper reported. The structural model was built based on cartographic data and the analysis of major tectonic events in periods with extensional and comprehensional regimes: i) the period with extensional regime during Triassic and Jurassic characterized by: a) continental rifting (Early-Middle Triassic), b) continental break-up (Later Anisian) resulting in the separation of the Korabi - Pelagonian microcontinent from the Adria = Apulia plate, c) oceanic spreading during Triassic and Jurassic accompanied by the installation of a graben megastructure with the oceanic basin in the center, the two slope - basins, the passive continental margins (Qerret - Miliska in the west and Mbasdeja to the east) and two restrictive platforms (Hajmeli in the west and Gjallica in the east), ii) the period with a comprehensional regime during the Middle Jurassic, the beginning of the Late Jurassic characterized by the closure of the Mirdita's oceanic basin where two deformational stages are distinguishable: a) stage M-1, J_2. Plunge and bidivergent interoceanic paleoemplacement of Jurassic ophiolites above the Triassic ones, and formation of metamorphic sole within them, and, b) stage M-2, J_2^{c}-J_3^{ox1}. This stage was characterised by the plunging of continental margins and bidivergent obduction of Triassic and Jurassic ophiolites onto the continental margins have. As a result of these two stages, Mirdita's "megasinclinorium" structure was formed, iii) period after closure of Mirdita oceanic basin (Late Jurassic - Cretaceous) with a very little deformed structures of flysch, flyschoidal and molassic Upper Jurassic and Cretaceous formations, covering with underwater unconformity or transgression ophiolites and Triassic – Jurassic continental formations, after closure of oceanic basin, v) during the deformational phase of the Late Eocene - Early Oligocene (M-3, Pg_2^3 - Pg_3^1), occurred overthrusting of Mirdita Zone onto the Outer Albanides and, vi) quasi-vertical faults during Pliocene - Quaternary has influenced on today's relief configuration.

Keywords: Mirdita Zone, ophiolites, continental margins, megasinclinorium, ophiolitic bidivergent interoceanic and marginal emplacement

1. INTRODUCTION

The Mirdita Zone, and especially its ophiolites, represents one of the most important structures of the Mediterranean alpine belt. It is part of the Dinaric belt s.l.

Aliaj and Kodra (2016) distinguished in the Dinarides s.l: the Dinarides s. s. - north of Shkodra - Peja trasversal fault, Albanides - between the Shkodra - Peja and Sperchios transversal fault and Hellenides - south of Sperchios transversal fault.

Table 1. Tectono - stratigraphic zones and subzones of Albania

D I N A R I D E S sl							
Dinarides ss		Shkoder – Peja Transversal	Albanides			Sperchios Transversal	Hellenides
Outer Dinarides	Inner Dinarides		Outer Albanides	Inner Albanides			Spread in Greece territory only
				MIRDITA ZONE			
KRUJA ZONE	GASHI ZONE		SAZANI ZONE	ADRIA	- Hajmeli Subzone - Qerret - Miliska Subzone		
CUKALI ZONE	- Seferçe-Çeremi Subzone		JONIKE ZONE				
ALBANIAN ALPS ZONE - Malesia e Madhe Subzone - Valbona Subzone	- Sulbica Subzone		KRUJA ZONE - Dibra Subzone	Triassic ophiolite + + + metamorphic sole + + + Jurassic ophiolite: western / eastern + + + metamorphic sole + + + Triassic ophiolite			
VERMOSHI ZONE			KRASTA ZONE - Okshtuni Subzone - Ostreni Subzone	KORAB - PELAGONIA	- Mbasdeja Subzone - Gjallica Subzone		
					KORABI ZONE - Çaja - Korabi highland Subzone - Kollovozi Subzone		

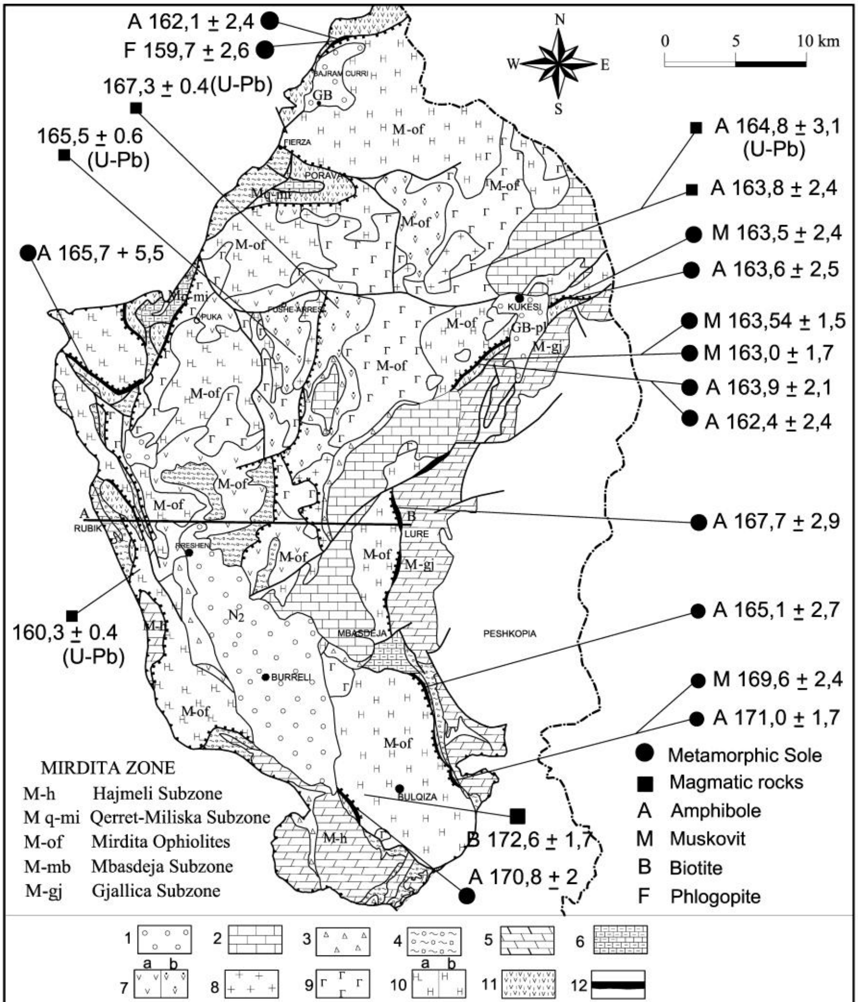
The three basic units of the Dinarides s.l. are divided into inner and outer tectono-stratigraphic zones (Table 1). The main difference between them is that the internal zones have been subject to Jurassic and Tertiary deformational stages, and are characterized by the presence of ophiolites, whereas in the outer zones their Mesozoic sections are continuous and subjected only to deformational tertiary stages and are characterized by missing of ophiolites.

Two zones could be distinguished in the Inner Albanides: Mirdita and Korabi zones.

Many scholars have considered the border of ophiolite with continental formations at their east side as the boundary between Mirdita and Korabi zones. There is however a contradictory interpretation since continental formations outcropped to the west of the ophiolites up to their overthrust planes over the Krasta flysch are included in the Mirdita Zone.

Shallo *et al.,* (1980) and Shehu *et al.,* (1990) included the ophiolite and carbonate peripheries in the Mirdita Zone.

Kodra and Gjata (1982), Kodra *et al.,* (2000), Xhomo *et al.,* (2002; 2005) and Aliaj and Kodra, (2016) included all the ophiolitic and carbonatic formations that were part of the construction of graben megastructure during the Triassic-Jurassic oceanic spreading in the Mirdita Zone (Fig. 1, 2).



1-Neogene molasse. 2-Cretaceous platformic limestones. 3-Upper Jurassic and Titonian-Valanginian supra-ophiolitic mass-flow deposits. 4-"Kaluri" radiolarite (J_2) and "Simoni" melange (J_2^c-$J_3^{ox_1}$). 5-6-Continental margins formations: 5-Mainly platformic limestones. 6-Mainly Hallstatt limestones. 7-10 Jurassic ophiolites: 7-Volcanics rocks: a-MORB type, b-JAT type. 8-Plagiogranites. 9-Gabbros. 10- Mantle sequences: a-Harzburgite-lherzolite type, b-Harzburgite type. 11-Triassic ophiolites: "Porava" formation. 12-Metamorphic sole J_2.

Fig. 1: Geological map of the Northen Mirdita Zone. A-B depicts the profile line for the structural cross-section shown in Fig.1/1. (After Xhomo et al. 2002 with supplements).

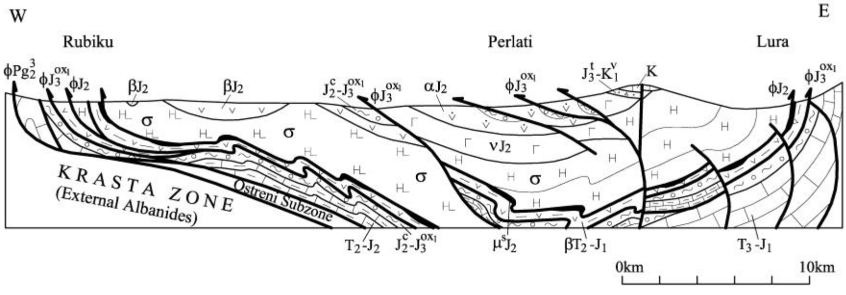


Fig. 1/1: Structural cross-section A-B (Rubiku - Perlati - Lura)
(For legend see Fig.1)

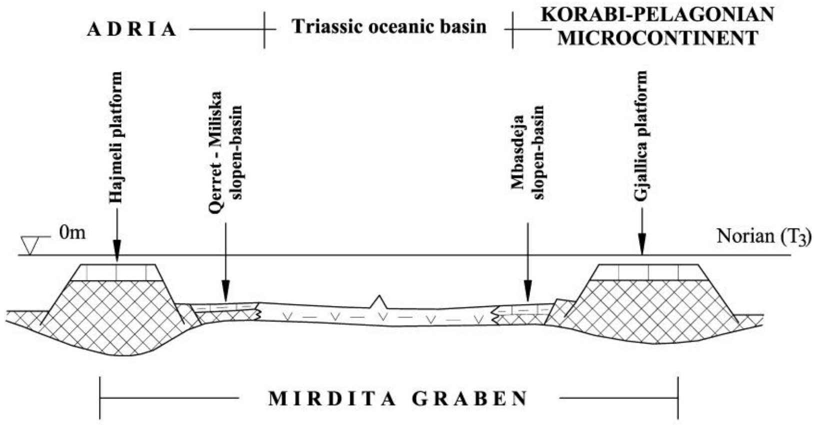


Fig. 2: Mirdita graben structure during Late Triassic.

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Another regionalization of the Mirdita Zone can be used: the Mirdita ophiolites in the centre, two tectono-stratigraphic zones part of the Adria plate in the west (Hajmeli and Gjallica), and two zones, part of the Korab - Pelagonian microcontinent in the east (Mbasdeja and Gjallica).

Basically, the two recent regionalizations do not differ from one another, only the second converts the tectono-stratigraphic subzones into zones. In the present paper, the authors mention the regionalization widely used for four decades

The forthcoming paragraph describes the geological structure of the Mirdita Zone.

2. MIRDITA ZONE

First, the authors describe the subzones with continental formations on the both sides of the ophiolites and then to the later ones.

2.1. Tectono- stratigraphic subzones to the west of the ophiolites

The Hajmeli and Qerret - Miliska (part of the Adria plate) subzones are located in the west of the ophiolites.

2.1.1 Tectono-stratigraphic Hajmeli subzone

Hajmeli subzone is located in the westernmost part of the Mirdita Zone. To the east, its formations are submerged under the Qerret - Miliska subzone formations or below ophiolitic massifs. In the west the Hajmeli Subzone has intensively overthrusted the flysch formations of the Krasta Zone. The Figure 3 depicts the formation of the Hajmeli subzone. In the framework of the geotectonic evolution of the Inner Albanides, Hajmeli's subzone has represented the southwestern bounded platform of the large Mirdita graben megastructure that had Mirdita oceanic basin at its centre (Fig. 2).

Geological structure of Hajmeli subzone is generally monocline structure, dipping east, complicated by apparent western vergence and rarely represented by reversed folds. Monocline strikes are encountered in many places, but the area where can be widely observed and followed for many and many kilometres, is from Gurra e Madhe, south of Klosi, Plani i Bardhë up to Staveci, etc. Reversed folds with western vergence are evidenced in Mali i Hajmeli, Gurrë e Vogël and Derstila. There are only asymmetric folds with western vergence in Mali i Velës and Mali me Gropa due to the significant thickness of limestones. The foldings of Hajmeli subzone formations have initially happened during obduction of ophiolites onto the continental margin, and later, Mirdita Zone overthrusted the flysch formations of Krasta Zone.

As for Hajmeli Subzone, it could be noted: i) for all the hundreds of kilometers strikes of the Hajmeli Subzone, in no case have been documented foldings with eastern vergence, and ii) many condensed limestones outcrops of red ammonitic with manganese stains of Lower - Middle Jurassic age (reddish Staveci limestones), overlain platformic limestones of Upper Triassic - Liassic (Kodra *et al.*, 1979).

The Staveci limestone appear very soft, slightly or too little deformed and unmetamorphosed. Even the many microfossils such as *Involutina liassica, Protoglobigerina sp., embryonic ammonites, Trocholina sp., echinodermate, Lenticulina sp., lagenidae, ostracoda, radiolarie, Dentalina sp.* etc, that are met within, appear undeformed and very well preserved (Xhomo *et al*., 2002).

Reddish Jurassic limestone Staveci have the smallest degree of metamorphism as the coeval of Jurassic red ammonitic limestone in the Ionian Zone, Valbona Subzone or in Lisna and Spiteni sections.

The same thing can be also said for the radiolarite cherts of Middle Jurassic that follow above the Staveci limestone. The radiolaria of these cherts are very well preserved, just like coeval radiolaria in the radiolaritic cherts on the roof of ophiolites. These data prove that this part of the Hajmeli Subzone which is exposed to ophiolites surface today has never overthrust this surface, i.e., the boundary of the ophiolites with the Hajmeli Subzone formations, in general has been the old boundary of ophiolite obduction onto the southwestern margin of the Mirdita ocean basin. Based on the aforementioned data, we oppose the interpretations of (Robertson and Shallo 2000; Dilek *et al.,* 2007) etc., according to which the ophiolites originate in a spreading oceanic basin in the Krasta - Pindi trough, and then they are obducted eastward over the Korabi - Pelagonia platform, part of which they also considered the Hajmeli subzone. Such obduction of ophiolites over Hajmeli subzone, would undoubtedly be associated with deformations in folds with eastern vergence of formations of this Subzone. Even the Staveci limestone and radiolarite and other depositions above them, would have been subjected to deformations, schistosity and metamorphism by such an overthrust of large masses of several kilometres thickness of ophiolites.

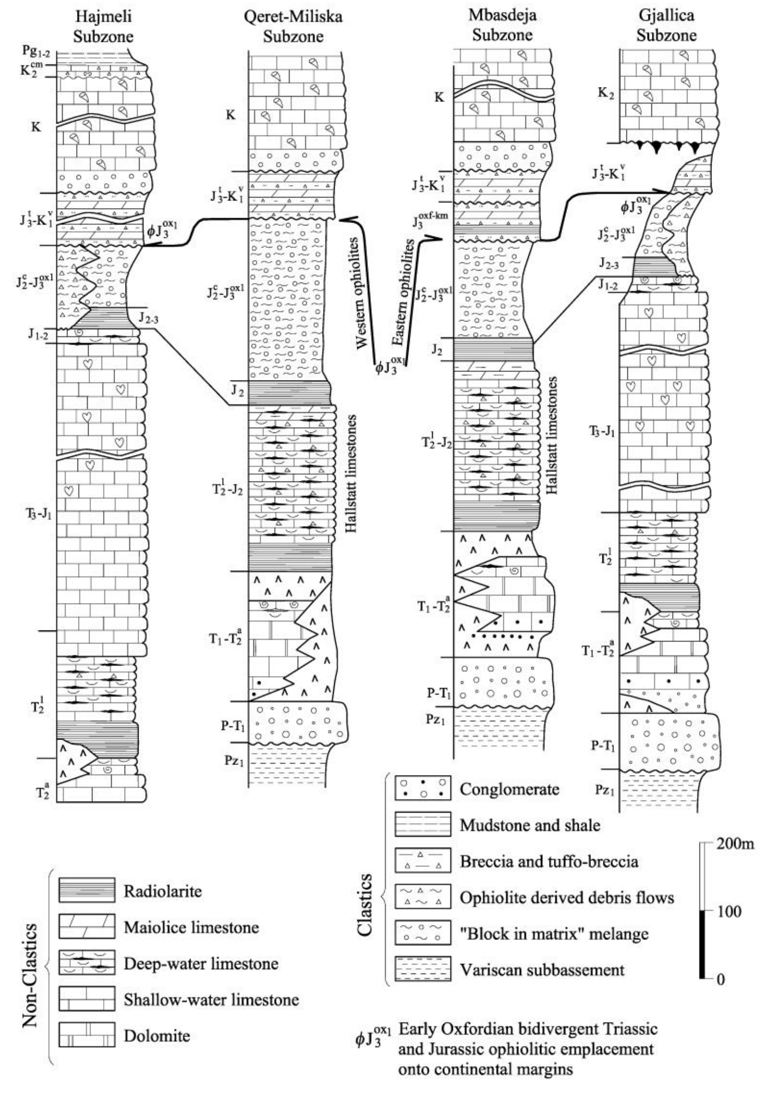


Fig. 3: Lithostratigraphic columns of the tectono-stratigraphic units (Mirdita Zone).

2.1.2. Tectono - stratigraphic subzone of Qerret – Miliska

Qerret - Miliska Subzone formations are spread mainly in the northern areas of Miliska, Qerreti, Komani, Kçira and, rarely in the southern most areas.

Less outcrops like tectonic windows below ophiolites are exposed in Fregeni, Nderbunga, etc.

Qerret - Miliska subzone is largely covered by volcano - sedimentary Porava formations and the western Mirdita ophiolites. The litostratigraphic column of this Subzone is in the Figure 3 depicted. The main rocks of the Qerret - Miliska Subzone are represented by pelagic limestone of "Hallstatt" facies of Middle Triassic - Middle Jurassic that served as the basin - the slope, the southwestern passive continental margin of the Mirdita oceanic basin (Fig. 2). Among the main structures of this Subzone, we distinguish the Miliska anticline formations perform west - east strike and clear periclinal closure towards the east, submerged below ophiolitic formations (Fig. 1, 4). Folded structures with north-western vergence are observed in Qerreti and west of Komani. In Kçira, anticline cores have predominantly western vergence.

2. 2. Tectonono - stratigraphic subzones to the east of ophiolites

To the east of the ophiolites, in the framework of the Mirdita Zone, as western part of the Korabi - Pelagonian microcontinent, are distinguished into two subzones: Mbasdeja and Gjallica subzones (Tab. 1, Fig. 1, 2).

2. 2. 1. Tectono - stratigraphic subzone of Mbasdeja

The distribution of Mbasdeja formations is limited, as it is largely covered by the eastern ophiolites. The figure 3 depicts the synthesized lithostratigraphic column of Mbasdeja subzone. The present column shows the presence of Middle Triassic - Middle Jurassic pelagic limestone of "Hallstatt" facies. In western direction, formations of Mbasdeja subzone are clearly submerged below Kukësi, Bulqiza, Lura and Shebeniku Triassic and Jurassic ophiolites. In eastern direction, formations of Mbasdeja Subzone have tectonically thrusted the Çaja subzone. The formations of Mbasdeja subzone are considered as highly folded, north - south strike, with eastern vergence or reversed vergence to the east. Axial planes of folds dip toward west at 30^0 - 75^0.

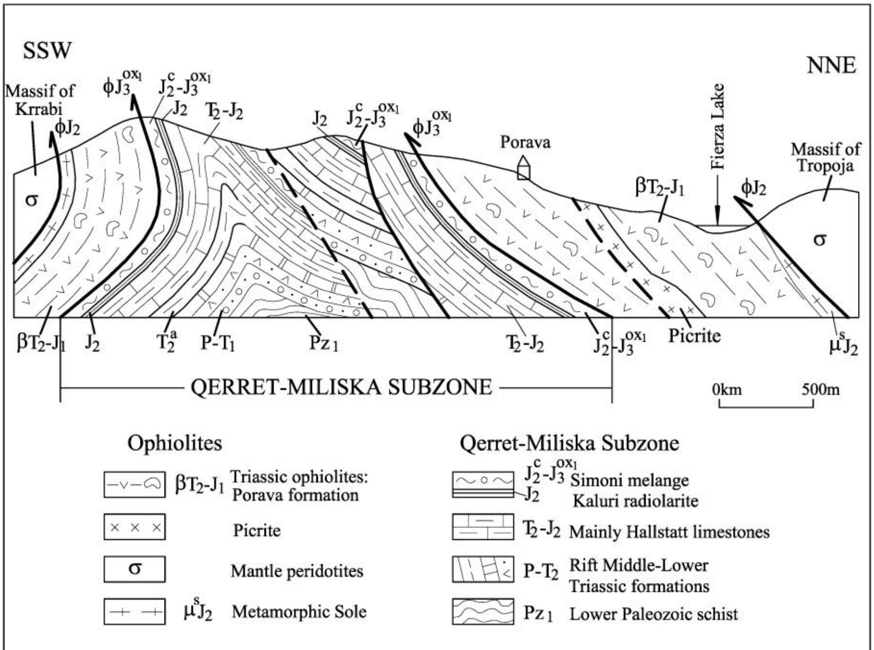


Fig. 4: Triassic and Jurassic ophiolitic emplacement onto Qerret-Miliska Subzone formations (After: Kodra 1976, Xhomo et al. 2002, with supplements).

In area Volljaku - Çupeva - Kralane (Kosova) (Fig. 5) are exposed tectonic windows of the Callovian-Oxfordian formations of the Mbasdeja subzone below the Mirdita ophiolite formations, obducted above them. Ophiolitic breccia, Çupeva radiolarite of Oxfordian - Kimmeridgian*, along with Volljaku flysch of Kimmeridgian - Lower Tithonian*[2] cover with unconformity, like depositions and tectonic windows of Mbasdeja Subzone, as well as ultrabasic formations, obducted above them (Elezaj and Kodra 2008; 2012; Kodra *et al.,* 2009; Sukaj 2015). Çupeva radiolarite and Volljaku flysch are very little deformed.

In Mbasdeja area, Triassic and Jurassic ophiolitic formations and “Hallstatt” limestones, along with their Jurassic cover are covered with unconformity by” Firza” flysch of Upper Tithonian - Valanginian and Cretaceous platformic limestones little deformed (Fig. 6) (Shehu *et al.*, 1983; 1990; Xhomo *et al.,* 2002; 2005). It is possible that, at the lowest levels of discordant depositions can be found limited Kimmeridgian - Titonian flysch.

** Paleontological definitions by prof. Chiari, M. *[1] Paleontological definitions by prof. Pirdeni, A.*

In the palaeotectonic context, after the continental break-up of the Late Anisian, during the spreading of the Mirdita ocean (Ladinian to Middle Jurassic), the Mbasdeja Subzone was a slope-basin at the northeastern continental margin of Mirdita's oceanic basin, where mainly the Hallstatt facies limestones were deposited. In the northeast, the Mbasdeja basin –slope, through the listric faults, was bordered by the Gjallica platform (Fig.2). Mirdita's ophiolites were obducted during the Late Callovian - Early Oxfordian onto the Mbasdeja Subzone. Sedimentary deposits of Çupeva and Volljaku of Upper Jurassic post - date the obduction of the ophiolites onto the eastern continental margin.

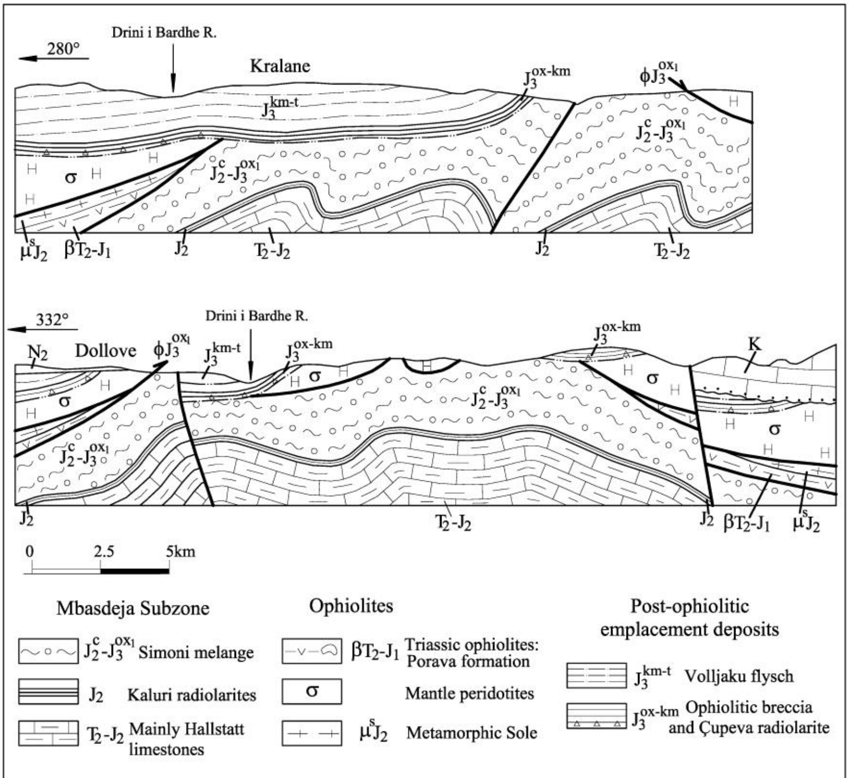


Fig. 5: Upper Jurassic and Cretaceous depositis discordantly cover Simoni melange and mantle peridotites of the overthrusting over it.

2.2.2. Gjallica tectono - stratigraphic subzone

Figure1 depicts the Gjallica subzone widely spread in eastern part of Mirdita Zone. In the west, it is tectonically plunged below the formations of Mbasdeja Subzone and is partly covered by Mirdita ophiolites. To the east, it tectonically thrusts Çaja subzone.

Figure 3 depicts the synthesized litostratigraphic column of Gjallica's subzone. Unlike the "Hallstatt" pelagic limestone of Mbasdeja subzone, the Triassic-Liassic limestones of the Gjallica subzone belong to shallow waters and have a considerable thickness.

Kodra (1976; 1986), Godroli (1992), Kodra and Gjata (1996), Xhomo *et al*., (2002), Hoxha (2006) and Kodra and Hoxha (2015) clarified the tectonic characteristics of the Gjallica subzone, which, to a large extent depend on the tectonic deformations occurred in the Late Callovian - Early Oxfordian and are related to the obduction of ophiolites onto northeastern continental margin during the process of closing the Mirdita oceanic basin. As a result, we have almost a full coverage of Mbasdeja subzone and western part of Gjallica subzone.

The basic feature of the Gjallica subzone structure is in general monocline strike of the western slopes of its formations (western part of Mali i Thatë, the formations at the east of the Shebenik, Bulqiza, Lura and Kukësi ultrabasic massifs). Unlike the neighbouring zones with pelagic formations (Mbasdeja, Çaja), which appear highly folded up to reversed with eastern vergence, in Gjallica subzone, because of the large thickness of limestones their folding has been limited, but always with eastern vergence.

It could be noted that structures of the Gjallica subzone are from the south to the north step by step subject to deviations from the Dinaric strike to meridional, whereas in Kukësi territory, are evidenced deviations of structures to northeastern direction. These deviations, among other things, are related to the role of the transversal faults, especially the northern ones, such as the Vlora - Dibra, Mbasdeja – Selishta, Kurbneshi - Arrëmolla, and especially Rrësheni - Prizreni transversal fault. The latter is very important and parallel to Shkodra - Peja transversal fault. As a result, Elezaj and Kodra (2008; 2012) said that the northern paleogeographic end of the entire Korabi - Pelagonian microcontinent extends from the east of Kukësi towards Prizreni and further.

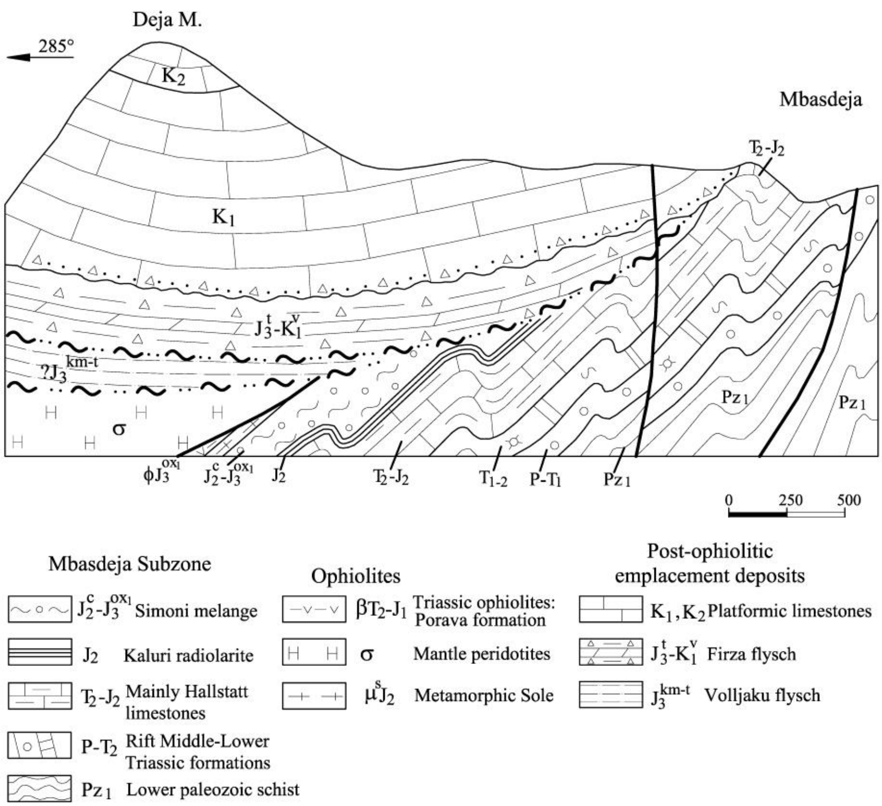


Fig. 6: Jurassic - Cretaceous and Cretaceous depositions discordantly cover Mirdita ophiolite and Mbasdeja Subzone formations.

In the Gjallica subzone, the dips of the formations are steep and very steep towards the west, and in its the western they are overturned towards west-northwest due to the events occurred during the obductions of ophiolites onto the formations of the eastern continental margin in the Late Callovian – Early Oxfordian. Under comprehensive regime, the listric paleo-faults of the eastern part of the Mirdita graben structure has passed to inverse faults, generating steep dip angles, and in many cases, overturning of the formations among inverted listric faults (Gjegjani, Gryka e Vanave, Skavica, Fushë-Lura etc. This tectonic style explains the cases of the overturning of formations of Gjallica subzone and those further in the west (Kodra 1976; Godroli 1992; Hoxha 1996; Xhomo 2002; 2005).

Formations of Gjallica subzone represent the lowest grade of metamorphism. Particularly this is evidenced in the condensed limestones of red ammonitic type of Lura (Lower - Middle Jurassic) that follows above the Triassic - Liassic platformic limestones. Lura reddish limestones are similar to the Staveci limestones of Hajmeli subzone. The lack of metamorphism is evidenced by the composition of the field outcrops and the numerous microfossils like *Involutina liassica*, *embryonic ammonite*, *protoglobigerina*, *radiolaria*, *etc*. that are very well preserved. The same thing should be said about the radiolarites that follow above the Lura, limestone, which are almost metamorphosed, just like their coeval analogues in the radiolaritic cover of the ophiolites.

The above data prove that this part of the Gjallica subzone, exposed to the surface, has never been subjected to the emplacement of ophiolites, as interpreted by many scholars, the place of origin of the Mirdita ophiolites is in Vardar, (Çollaku 1992; Bortolotti *et al.,* 2005; Gawlick *et al*., 2008; Trembley *et al*., 2015). Such an east-over-west obduction from Vardar's giant ophiolitic masses, some kilometres thick, would have been associated with folding with western vergence formations, intensive schistosity and elevated grades of metamorphism, in particular of Lura reddish limestones and other Jurassic deposits on top of them; which in fact are quite the opposite. These facts also testify that the paleoboundary of ophiolites with eastern continental formations is generally quite close to today's boundary. This is also evidenced in the Mbasdeja (Fig. 6), Vrrini i Arrnit and Kobaja (Kosova) area, where the Cretaceous platformic limestones unconformity cover both ophiolites and Mbasdeja and Gjallica Subzone formations (Shehu *et al.,* 1983; Peza *et al*., 1983; Xhomo *et al.,* 2005; Knoblock and Legler 2006).

2.3. Ophiolites of Mirdita

Mirdita's ophiolites are the main components of Albanides, and they are the largest metal assets of Albania. Along with the wide distribution, in Albania's ophiolites are encountered full sections, from deep mantle sequences to the oceanic crust formations and their radiolaritic cover. Numerous researchers have worked for many years to offer the most detailed explanation of their geology and metallogeny. Shehu *et al.,* (1990), Meço *et al.,* (2000), Xhomo *et al.,* (2002) and many others reported on the ophiolites of Mirdita.

Figure 7 depicts the Triassic and Jurassic ophiolites and the metamorphic sole of Middle Jurassic met in the ophiolites of Mirdita.

2.3.1. Porava volcano - sedimentary formation (Triassic ophiolites)

The Porava formation could be met in the periphery and on the floor of the Jurassic ophiolites. They are mainly represented by Porava volcano -

sedimentary formation and some small massifs in the western part of the Jurassic ophiolites. The Porava formation is composed by basalts, radiolarites, shales, rarely metamorphized limestone etc. Thickness ranges from 150 - 800 m. Basalts of Porava formations belong to MORB type (Bortolotti *et al.*, 2004). The age of this formation, based on the numerous determinations of radiolaries, is the Middle Triassic (Ladinian) and the Upper Triassic (Marcucci *et al*., 1994; Këlliçi *et al*., 1994; Kodra *et al.*, 1995; Hoxha 1995; Chiari *et al.*, 1996; Xhomo *et al.*, 2002). Based on our interpretations, the age of the Porava formation should include also the levels of Lower Jurassic.

Xhomo *et al*., (2005) said that the Porava formation has numerous widespread areas and sections of up to 800 m. Important Cu deposits of VMS type, such as Gjegjani, Palaj - Karma, Rubiku, Porava etc. are related to this formation.

Porava formation has everywhere tectonically overlapped the "blocks in matrix" mélange of Upper Callovian - Lower Oxfordian and below the ultrabasic massifs of mantle sequence. In most cases, in this boundary are encountered metamorphic sole (Fig. 4). Thanks to the polarity of the pillow lavas, it is documented that in the western part of the Porava formation cases is presented with normal polarity and foldings with western vergence. In the eastern ophiolite areas, the Porava formation has a western dip and is complicated in folds with eastern vergence. There are many cases when the Porava formation is overturned as in Gjegjani, Surroji etc. (Kodra 1976, Trembley *et al.*, 2015).

The Porava formation and the small Triassic ophiolitic massifs are the remains of Mirdita oceanic basin, which, after the continental break - up of the Late Anisian, was spread under conditions of a MOR (Mid - Oceanic - Ridge) at a very low spreading speed (Kodra and Gjata 1982; Kodra *et al.*, 1994; 1995) (Fig. 9). This spreading has proceeded to the Jurassic oceanic spreading.

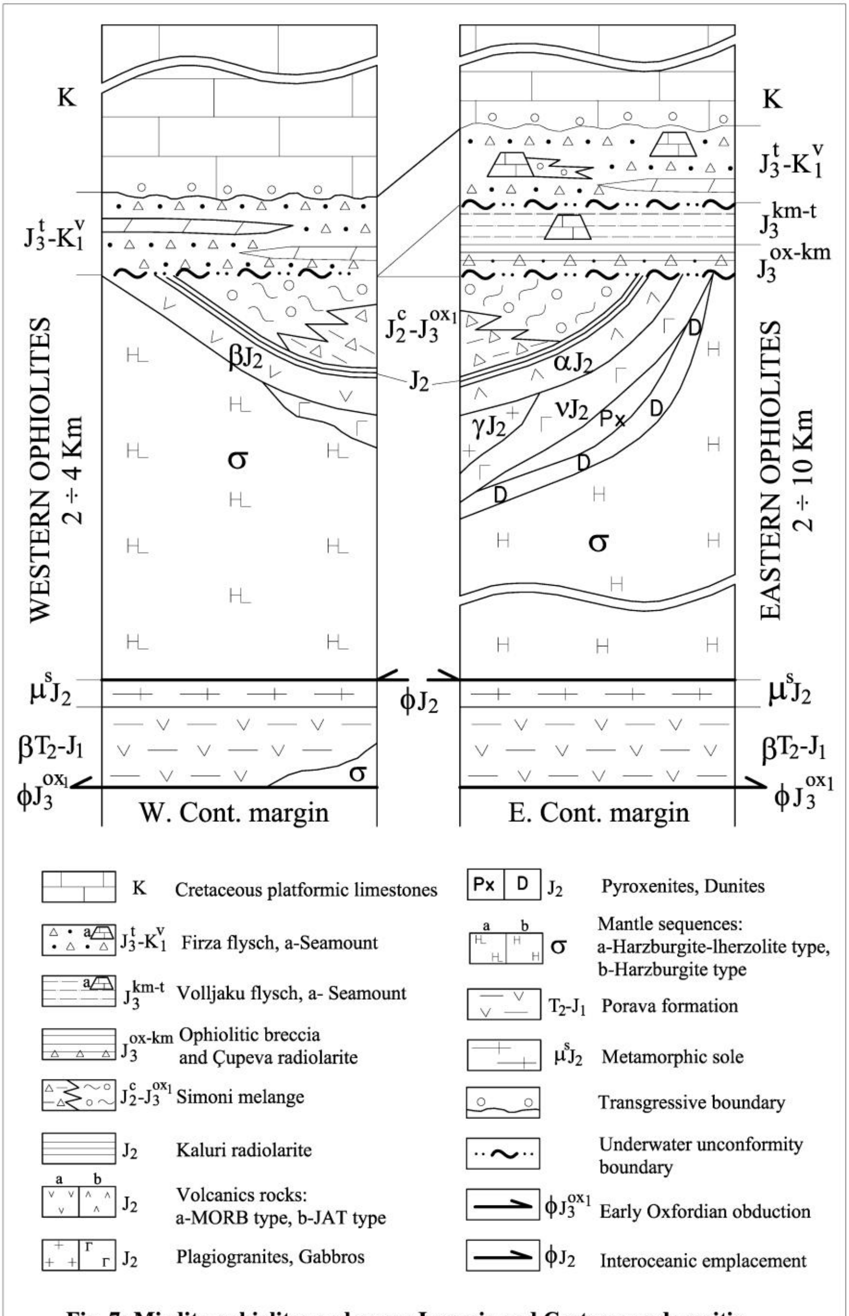


Fig. 7: Mirdita ophiolites and cover Jurassic and Cretaceous depositis.

2.3.2. Jurassic ophiolites

Figure 1 depicts the Jurassic ophiolites widespread distribution. Numerous scholars distinguished two types of Jurassic ophiolites: Western and Eastern type of ophiolites (Ndojaj 1967; Tashko 1975).

Western type ophiolites are incomplete ophiolites, formed under conditions of MOR, at low spreading speeds. Basalts belong to MORB type. Ultrabasic formations contain low chrome - bearings and chromite is mainly alumochromite.

The ophiolites of the eastern type are complete ophiolites. Many scholars said that they were formed under conditions interoceanic subduction (SSZ). There are also other options for the ophiolite formation (Tashko 1990; Kodra and Gjata 1982; Meshi and Hoxha 2008). An alternative point could be found in (Nicolas *et al.*, 1999). Here it is stated that the EOB as "typical ophiolitic" due to the characteristics of the WOB that contains an upper mantle sequence with milonitic lherzolites ascribed to successive episodes of active magmatic spreading and tectonic, non - magmatic extension with strong subhorizontal shearing at slow spreading rates.

Ophiolites of eastern type, or as they are called ophiolites of hartzburgitic - type (Nicolas *et al.*, 1999), are chromium-bearing and chromium itself belong to magnochromitic type. The essential difference with respect to the chromite between the western and eastern ultrabasic formations is related to the different degrees of melting of the mantle. Eastern mantle has had a higher degree of melting which has led to more abundant chromitic release and the formation of important deposits.

The age of Jurassic ophiolites is defined as Middle Jurassic based on numerous studies about the Kaluri radiolarites, among the volcanic ophiolites and as their primary sedimentary cover. Kaluri radiolarites provide extensional radiolaritic associations of Bajocian - Bathonian up to Callovian (Marcucci *et al.*, 1994; Këlliçi *et al.*, 1994; Kodra *et al.*, 1995; Prela 1996; 2000; 2010, etc.). In some sections, like Lumzi (Marcucci and Prela 1996), Qafa Bari (Marcucci *et al.*, 1994), Perlat (Kodra *et al.*, 1995, Xhomo *et al.*, 2002), the radiolarites located in the roof of ophiolites go up to the levels of Upper Callovian - Lower Oxfordian (index 8, UAZ95 - Baumgartner). Isotopic dating of ophiolitic plagiogranites give ages 160.3 to 165.5 My, close to those of the Kaluri radiolarites located in the roof of ophiolites (Tashko and Gjata 1990, Gjata *et al.*, 1992, Bebien *et al*., 1999). Dilek *et al.*, (2007) stated that the age of the Mirdita ophiolites is constrained by U/Pb zirconium age of 164.8 ± 3.1 My to 160.3 ± 0.4 My (Fig. 1).

In the sedimentary ophiolitic cover of the Middle Jurassic Kaluri radiolarites lies the Simoni mélange of Upper Callovian - Lower Oxfordian, which can be characterized as a "block-in-matrix" type, polygenetic mélange, the evolution of which occurred during the tectonic and sedimentary processes (Kodra 1987; Kodra *et al.,* 1996; Xhomo 2002; Trembley *et al.,* 2015). Simoni mélange, and coeval to it of ophiolitic breccias, are formed along the ophiolite obduction process above continental margin. On top of the obducted ophiolitic formations on the formations of the continental margins were deposited with underwater unconformity ophiolitic breccias, Çupeva radiolarites of the Oxfordian - Kimmeridgian and Volljaku flysch of Kimmeridgian - Tithonian (Elezaj and Kodra 2008; 2012; Kodra *et al.,* 2009, Sukaj 2015). The Oxfordian Age of the base of this formational group, post-date the age limit of the bidivergent ophiolite obduction onto the continental margins, namely the closure of the Mirdita oceanic basin.

Timely obduction interval is very short, and may be included between 165 and 160 million years. Even zircon fission tracks age of 156 ± 17 million years (Muceku *et al.,* 2006), is very close to the age of completion of ophiolite obduction onto the continental margins.

In the central part of the Mirdita Zone, during Kimmeridgian and Berriasian - Valanginian, in addition to the flysch and flyschoidal terrigenous deposits in the local extensional regimes in the limited areas, are also deposited the conglomeratic molasses and platformic limestones (Melo *et al.,* 1971; Meço 1977; Meço *et al.,* 1975; Peza *et al.,* 1983; Peza 2006; Gawlick *et al.,* 2008; Schlagintwit *et al.,* 2008; Uta 2018). In this context, we don't agree with the opinions in (Gawlick *et al.,* 2008; Schlagintwit *et al.,* 2008), for broad carbonated platforms during Kimmeridgian and Berriasian - Valanginian. To us, the most accurate is interpretation of seamounts, where shallow water carbonates are deposited in the environment of a deep sea, where Volljaku and Firza flysch and flyshoidal terrigenous sediments were deposited on the top of ophiolites, and so on.

After the Hauterivian conglomeratic lifting of Barremian (?) and Cretaceous platformic limestones of, widely and cover transgressively underlayered formations. (Peza *et al.,* 1981; Xhomo *et al.,* 2005).

On the Cretaceous limestone, which rarely reaches the Paleogene levels, lie with the discordance molasses of Eocene, Oligocene and Miocen – Pliocene.

2.3.3. Metamorphic sole

Figure 1 depicts the metamorphic sole rich in amphibolite garnets, garnet-mica-schist and green shales spread to the lateral parts of Mirdita ophiolites. Metamorphized lenses of limestones, quartzites, etc. could be rarely met.

Intensive metamorphic sole studies carried out in Mirdita Zone, have determined its rigorous position between the Triassic volcanic-sedimentary formation Porava (below) and the ultrabasic mantle sequences (above). This position could be noted in tens of dozens of field cuttings (Kodra 1976; 1986;

Kodra and Gjata 1982; Kodra *et al*. 1993; Godroli 1992; Hoxha 1996; Dimo 1997; Xhomo *et al.*, 2000; 2002; 2005). Mainly harzburgitic mantle sequences, at their lower part, near the metamorphic sole boundary, appear under conditions of HP-LT (Fig. 12) (Meshi 1995; Meshi *et al.*, 2005). Vertical changes in the metamorphic sole are quick, inverse, with the principle of ironing mechanism (Çollaku 1992). The transition from the metamorphic sole to the Porava volcano-sedimentary formation occurred gradually through green schists.

The geochemistry of the metabasic rocks of the metamorphic sole shows mainly MORB affinities. In rare cases, we have WPB and OIB affinities (Godroli 1992; Shehu *et al.,* 1990; Xhomo *et al.,* 2002).

Numerous isotopic definitions, mainly 39Ar/40Ar document age 159, 7 - 172, 6 Ma for metamorphic sole (Ivanaj 1992; Gjata *et al.,* 1992; Kodra *et al.,* 1994; 1995; Dimo 1997; Dilek *et al.*, 2007) (Fig. 1), i.e., the Middle Jurassic Age very close to the Age of the ophiolites and Kaluri radiolarites on the roof of ophiolites.

The microstructural analysis of the metamorphic sole rocks has resulted in contradictory data, showing west-over-east and east – over - west shear - sense indicators (predominantly in the garnets). (Çollaku 1992; Godroli 1992; Dimo 1996; Hoxha 1996). In contrast, structural data prove in favour of the west - over - east paleoemplacement of eastern Jurassic ophiolites onto the Porava volcano - sedimentary formation. In the eastern regions of Mirdita Zone, many cases of folded metamorphic sole or with microfolds with eastern and rarely northeastern vergence were reported. The axial planes of folds dip to the west at angles 10° - 70°. Schistosity S_1 in amphibolites, in green and micaceous shales have predominantly north - south strike and western dip.

In Greece, some microstructural studies have been focused on the infra - ophiolitic rocks, especially from Vourinos massif etc. Data reported that the obduction of the ophiolites on the continental Pelagonian formations has been in the west – over - east direction (Rassios and Moores 2006; Ghikas *et al*., 2015).

The formation of the metamorphic sole is explained as follows: in the combined tectonic regime, the marginal parts of the new and hot Jurassic oceanic lithosphere, progressively overlap in two opposite directions over the uppermost parts of old lithosphere, submerged below it, by forming respectively metamorphic sole on both sides of these emplacements (Kodra and Gjata 1982). The boundary between the oldest (Triassic - Liassic) and the newest (Jurassic) lithosphere as the decoupling boundary, is in conformity with Nicolas, Le Pichon 1982 submissions, that such a boundary would be preferable among the lithosphere with different elastic properties.

The radiometric data demonstrate that western and eastern metamorphites have about the same age in the same their extent (Fig. 1), which supports the interpretations that the two-sided emplacement of the Jurassic ophiolites onto the Porava formation (βT_2 - J_1) occurred almost at the same time (Kodra and Gjata 1982; Godroli 1992; Dimo 1997). For the explanation of the diachronism about 10 million years, which is evidenced in the age of the metamorphic sole ($\mu^s J_2$) from the central areas (169 - 174 My) to the north (159 - 164 My), it is assumed as a variant of interpretation that the process of interoceanic paleoemplacement has started more rapidly in the central areas of ophiolites, rejuvenating northward. These changes apparently relate to the transformational transversal faults, where each segment of the oceanic crust between the two transversal faults has its location and own age formation. Not excluded in this interpretation the role of the north - northwestern (strike - slipe) component of paleoemplacement of Jurassic ophiolites (Meshi 1995; Carosi *et al.,* 1996; Nicolas *et al.*, 1999) has undoubtedly influenced on the different ages of the metamorphic sole, from the central part of the ophiolites, to north of them.

2.3.4. Data on the structure of ophiolites and their position in the megastructure of the Mirdita zone

After briefly reviewing the basic data for ophiolites, we will focus more extensionally on their structure, incorporated in the Mirdita megastructure, which has its major developments due to important events during Triassic and Jurassic.

During the Early Triassic - Middle Triassic in the extensional regime, continental rifting occurred, which was followed during Late Anisian by the continental break-up, dividing the Korabi - Pelagonian microcontinent from the Adria = Apulia plate. Following the extensional regime, the oceanic spreading was carried out, which was associated with the installation of the graben paleostructure with of the oceanic basin extending into the central part, two basin - slopes, passive continental margins, and two lateral limited platforms (Fig. 8).

This large Triassic - Jurassic paleostructure was completely restructured as a result of the powerful deformational phases that led to the closure of the oceanic basin during the Middle Jurassic until the beginning of the Late Jurassic (Fig. 9). The deformational phases of Inner Albanides were treated by many authors (Kodra and Gjata 1982; Kodra 1987; Kodra *et al*., 1993; 1996; 2000; 2015; Peza and Shkupi 1988; Peza *et al*., 1983; Peza 2000; Gawlick *et al*., 2008; Elezaj and Kodra 2008; 2012; Meshi and Hoxha 2010; Xhomo *et al*., 2002; 2005; Trembley *et al*., 2015; Aliaj and Kodra 2016).

Jurassic restructuring is finalized with the assemblage of two major "sinclinorium" structures: the "sinclinorium" of the continental formations on the periphery, and the basement of the ophiolites and the "sinclinorium" of the ophiolites with triassic ophiolites in the peripheral parts and mantle formations on top of them. Plutonic and oceanic crustal formations occupy central part of the ophiolitic "sinclinorium".

The paleomegastructure of the assemblages of the "sinclinorium" structures, is conditioned by plunges and interoceanic bidivergent paleoemplacement during the closure of the Mirdita oceanic basin. First, during the Bajocian - Early Callovian, the interoceanic bidivergent paleoemplacement of the Jurassic onto the Triassic ophiolites and the formation of the metamorphic sole between them occurred. Second, during the Late Callovian - Early Oxfordian, the bidivergent obduction of the ophiolites occurred mainly on the Apulian continental margin in southwest, and to a lesser extent onto the Korabi - Pelagonian continental margin in the northeast. So, there has been an asymmetry in the emplacement of ophiolites onto the continental margins (Fig. 1, 9).

Deformations of oceanic and continental formations, to folds with eastern vergence to the east, and western vergence to the west are mainly related to these two important deformational stages.

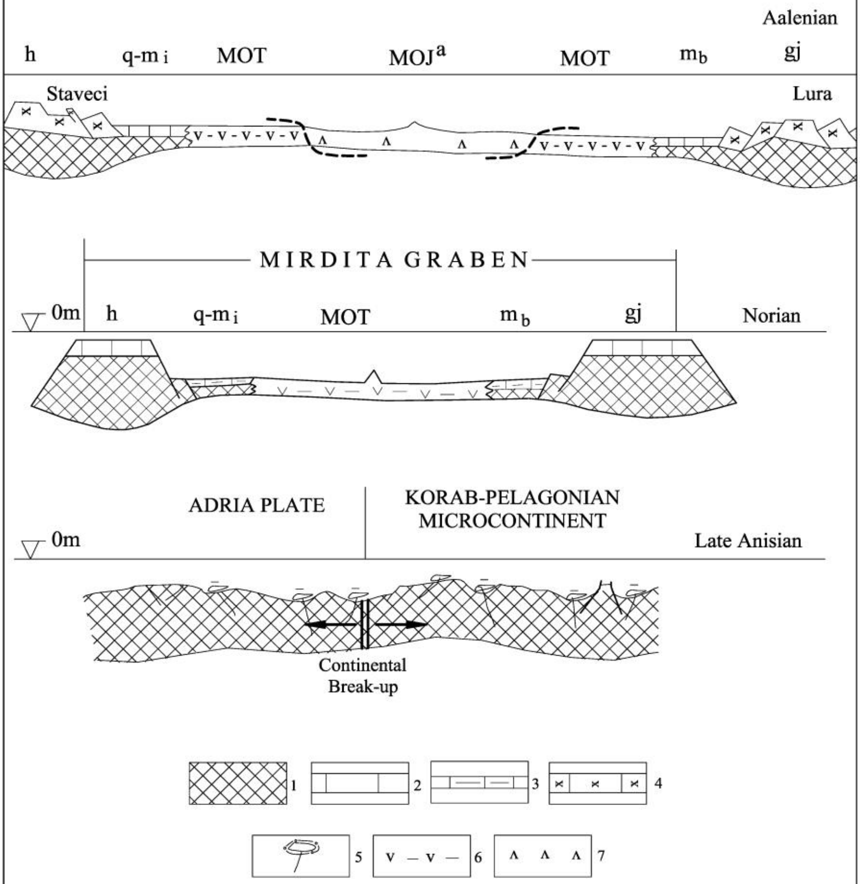
The tectonic style with interoceanic and marginal bidivergent plunge and emplacement, is a fundamental feature of the Mirdita Zone

The final stages of the closure of the oceanic basin were characterised by many thrusts and overthrusts in the east - west direction, particularly in the central Mirdita Zone, such as Reps - Perlat, Mashterkora - Kurbneshi, Qafë Bari - Gurthi - Kodër Spaçi, Truni - Sakati etc. Some of them might belong to back - thrust type, as responses to obduction of ophiolites onto the eastern continental margin. Consequently, further studies would be necessary.

Meshi and Hoxha (2008) described the closure of the Mirdita oceanic basin in two stages: firstly, the completion of ophiolite paleoemplacement to the east, and then (always within Jurassic), overlapping to west - northwest direction occurred.

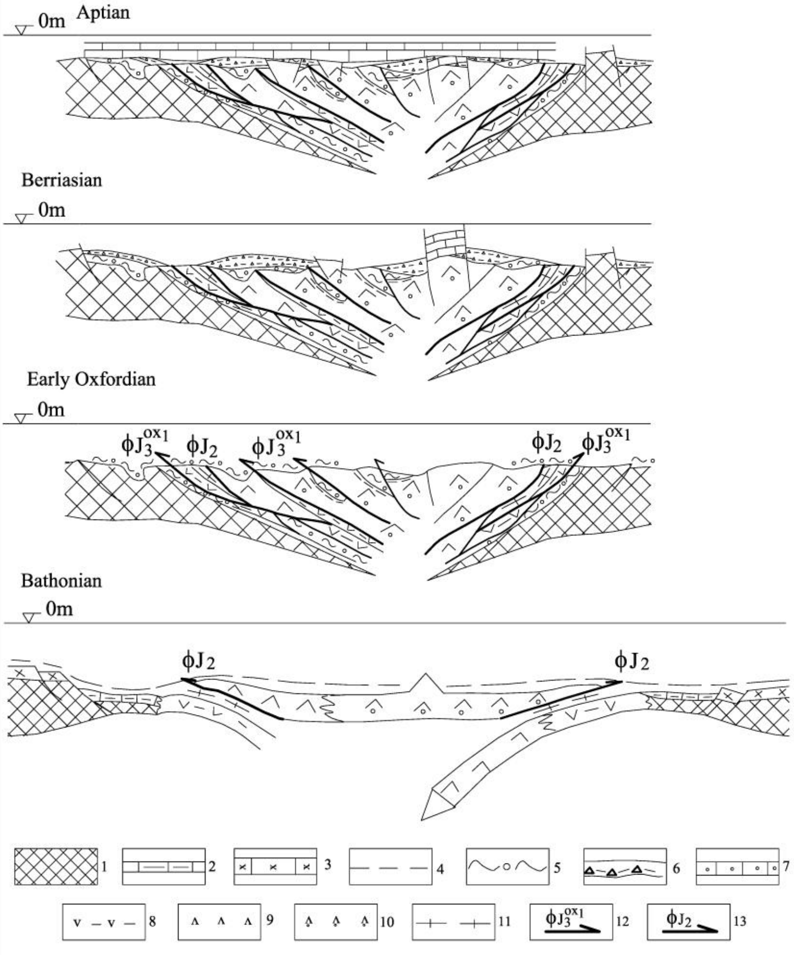
During the Hoterivian time almost rising of the Mirdita Zone occurred, but there were also areas where the deposits of ? Hoterivian - Barremian conglomerates and Aptian platformic limestones continued (Peza *et al.*, 1981; Xhomo *et al.*, 2002) (Fig. 9).

Many geophysical studies, mainly based on gravimetry and magnetometry helped define the thickness of the ophiolitic massifs, the geometry of their basement, and so on (Bushati and Dema 1985; Bushati 1988; 1997; Bushati *et al.*, 1994; Frashëri *et al.*, 2003; Langora *et al.*, 1983; Kodra and Bushati 1991).



1. The continental crust, 2. Platformic limestones. 3. Hallstatt limestones, 4. Condensed limestones with manganese nodules (Staveci and Lura limestones), 5. Rift related continental vulcanics , 6. MOT -Triassic-Liassic oceanic formation (Porava formation, etc), 7. MOJ-Middle Jurassic oceanic formation. (MOR type ophiolite). h-Hajmeli Platforme, q-mi-Qerret-Miliska Slope-Basin, mb-Mbasdeja Slope-Basin, gj-Gjallica Platforme.

Fig. 8: Diagrame of tectonic evolution of Mirdita Zone during the Late Anisian -Aalenian (Extensional regime), After Xhomo et al. 2002, with suplements.



1. The continental crust, 2. Staveci and Lura limestones. 3. Hallstatt limestones, 4. Kaluri chert, 5. Simoni melange, 6. Volljaku and Firza flysch, 7. Cretaceous platformic limestones, 8. Porava formation, 9. Western ophiolites, 10. Eastern ophiolites, 11. Metamorphic sole, 12. Marginal ophiolitic emplacement, 13. Interoceanic emplacement.

Fig. 9: Diagrame of tectonic evolution of Mirdita Zone during the Middle Jurassic - Cretaceous (after Xhomo et al. 2002, with suplements).

Another basic characteristic of Mirdita composite structure is the sharp curvature of the ophiolitic and continental formations, from the "Dinaric" NNW - SSE direction in the southern and central part, to the SW- NE in the northern part (Fig. 1).

There have been different opinions about this problem (Tashko 1990; Shallo 2018). Our opinion is that, the important role in this great structural deviation has played transversal faults. For many decades the great Shkodra - Peja and Vlora - Dibra transversal faults have been known. Some of the other transversal faults were introduced years ago. Among them, Korça, Selishta - Radomira, Kurbneshi - Lura (Kodra *et al*., 2000; Xhomo *et al*., 2002).

In the present paper the authors have made a significant modification to the scheme (Kodra *et al*., 2000), after identification of Rrësheni - Prizreni transversal fault parallel to Shkodra - Peja transversal fault (Fig. 10).

All these transversal faults have the right-side sense.

The main deviation of the ophilitc and continental structures of the Mirdita Zone has occurred between the Shkodra - Peja transversal fault in the north, and Rrësheni - Prizreni transversal fault in the south.

The regional significance of the Shkodra - Peja transversal fault is emphasized by many scholars. Kober (1929) separated the Dinarides s. s. to the north, and Hellenides to the south based on the Shkodra - Peja transversal fault.

Aliaj and Kodra (2016) separated the Dinarides s.s in the north from the Albanides in the south based on Shkodra - Peja transversal fault. The later continues in the Greek territory to the Sperchios transversal fault, followed by the Hellenides to the south (Fig. 10).

Dercourt (1968), Xhomo *et al*., (1969), Aubouin and Dercourt (1975), Papa *et al*., (1991), have considered the Shkodra - Peja transversal fault as a transversal fault that conditioned the paleogeographic closure of the Albanian Alps Zone. In its northeastern part, the paleogeographic closure of the Mokna platform unit is otherwise known as Golia or Drina - Ivanjica (Elezaj and Kodra 2008; 2012).

Rrësheni - Prizreni transversal fault is the main source not only for the the sharp turnaround of the ophiolites, but also for the continental formations to the east of the ophiolites and has conditioned the northern paleogeographic closure of the Korabi - Pelagonian microcontinent (Elezaj and Kodra 2008; 2012).

Other transversal faults in the south of Rrëshen - Prizren transversal fault and particularly of the Kurbneshi - Lura one, have played a noteworthy role.

These transversal faults have their beginnings in the Late Anisian. Their installation is related to the fundamental regional changes of the Tethysian oceanic basin spreading in the Dinaric segment, starting with the continental break - up that separated the Korabi - Pelagonian microcontinent from the Adria = Apulia plate and continued with the Mirdita ocean spreading etc.

Transversal fault issues in framework of entire Dinarides s. l. need detailed studies to highlight their importance in geological evolution. There are still many questions to be addressed to, e.g. the reason why plutonic (gabbro, mesoacidic rocks) and oceanic crust formations have been subjected to drift towards the northeast, while foliation in the mantle sequences continues to maintain generally a north-western strike. The same thing was observed in Kosova; in many years of investigations carried out in the north-eastern areas of Albania's ophiolites, we noted that such northwestern strikes also prevail in the rocks sequence formations in the Qafë Prushi - Deva - Ponosheci areas (the eastern part of the Tropoja massif) and in the Rahovec massif, which represents the northeastern extremity of the ophiolites of Mirdita Zone (Kodra *et al*., 2009). As for northern part of Albania, the foliation strikes of the ultrabasic massifs of the eastern part of the ophiolites and the southern part of the Tropoja massif, differ with the strike of banded texture of Kaptina gabbros massif structures to understand this pronounced structural unconformity (Nicolas *et al*., 1999; Xhomo et al., 2005; Meshi *et al*., 2005) (Fig. 11). Hoxha (1993), Nicolas *et al*., 1999 and Meshi *et al*., (2005) provided very interesting data about the north-eastern lineation of Kukësi massif, in contrast to the generally north - south lineation in the other massifs of the eastern belt.

The composition and orientation of dykes is very important to the progress of the oceanic basin spreading and its structural aspects. The composition of dykes is very well studied. Meshi *et al.*, (2005; 2010) made 558 measurement and stereograma northeastern strike.

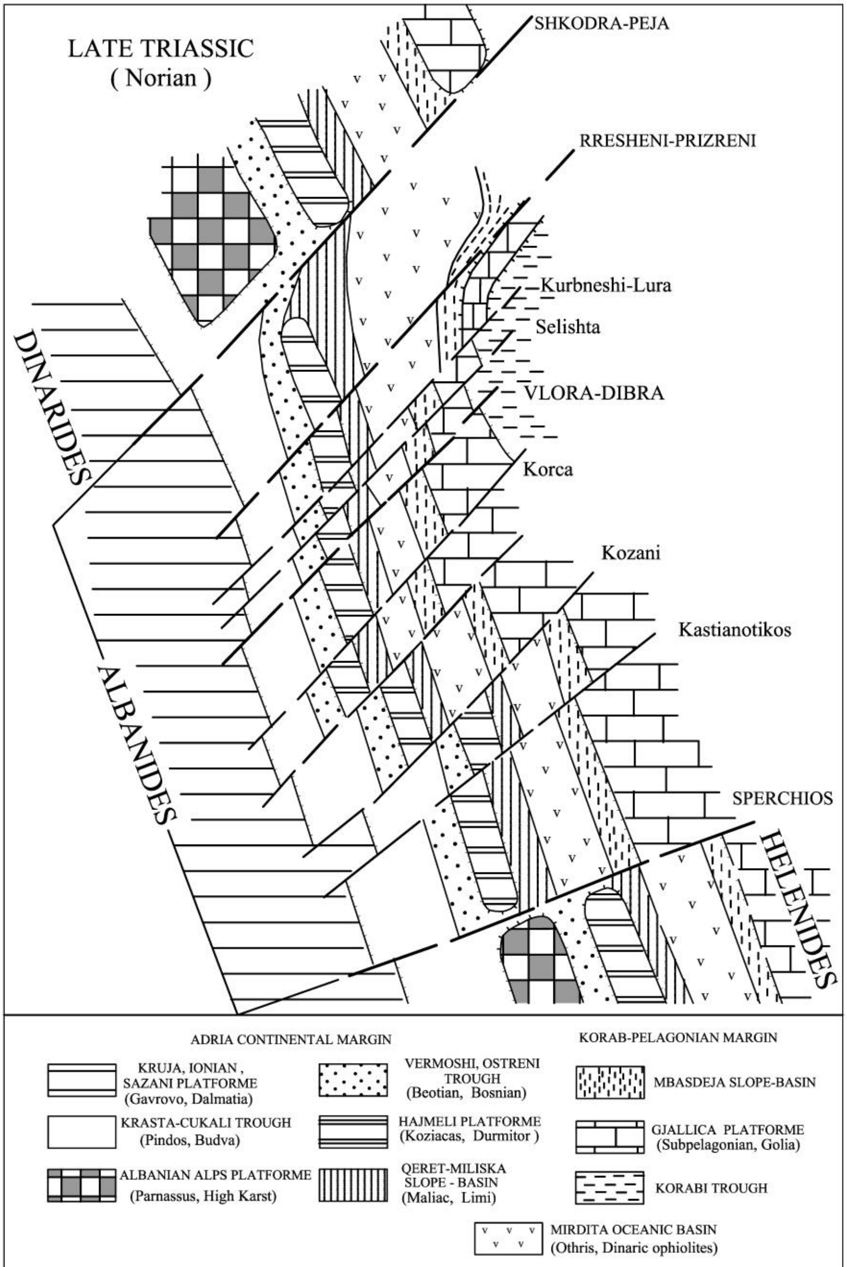


Fig. 10: Paleogeographic sketch of the Late Triassic (Norian) (after Kodra et al. 2000, Xhomo et al.2002 with supplements).

The internal structure of ophiolitic massifs of Albania was studied involving new ideas and innovative methods for several decades by (Meshi 1995; Meshi, *et al*. 2005; Nicolas *et al*., 1999; 2010). These studies are very important as they address the internal structure of the Mirdita ophiolites.

Another important structural feature of the Mirdita Zone is the striking with spread of regional structural unconformities of sedimentary deposits on ophiolites and continental formations on their periphery after the closure of the Mirdita oceanic basin.

In these deposits are included: i) ophiolitic breccias and Çupeva radiolaritic cherts of Oxfordian - Kimmeridgian, and Volljaku flysch of Kimmeridgian - Lower Tithonian, continuing in the Çupeva cherts (Elezaj, Kodra 2008; 2012; Kodra *et al*., 2009; Sukaj 2015). These depositions have very limited distribution in Mirdita Zone, ii) flysch and flyschoidal deposits of Upper Tithonian - Valanginian (Firza flysch) and locally limestone of the shallow waters and conglomerates of Berriasian - Valanginian (Gjata *et al*., 1989; Peza *et al*., 1981; 1983; Shehu *et al*., 1990; Xhomo *et al*., 2002; 2005, Bortolotti *et al*., 1996). Until now, no section with continuous depositions from Volljaku to Firza flysch has been met, iii) basal conglomerates of Barremian and Cretaceous platformic limestones (Peza *et al*., 1991; Shehu *et al*., 1983; Xhomo *et al*., 2002).

Regardless of the underwater unconformity or transgressive layering of above - mentioned depositions, there is no apparent structural unconformity between them. In general, all these depositions present slight deformations in gentle brachysyncline, unlike the ophiolite formations and their primary sedimentary cover which are very deformed. They perform unconformity strikes in both uppermost levels of the ophiolites (basalt, Kaluri chert and Simoni mélange) and up to the lower levels represented by the mantle sequences as well as up to the Triassic - Jurassic continental formations (Shehu *et al*. 1983; 1990; Xhomo *et al*., 2002; 2005).

In the Kralana - Volljaku - Çupeva areas, are mapped of structural unconformities between the Çupeva radiolarite and Volljaku flysch on the tectonic window of Upper Callovian - Lower Oxfordian deposits and the ultrabasic formations that are charriaged on them (Elezaj and Kodra 2008; 20012; Kodra *et al*., 2009; Sukaj 2015). Çupeva radiolarite and the Volljaku flysch that follows normally and gradually above, appear with minimal deformities into syncline brachyfolds (Fig. 5).

In the central part of the Mirdita Zone, sedimentary deposits, after the closure of the Mirdita ocean basin, were widely spread. For example, in the Shenjti and Deja Mountain ranges, ranging from Xhuxha to the north to Mbasdeja to the southwest, the Firza flysch of Jurassic - Cretaceous and the Cretaceous platformic limestone strike over different ophiolitic formations and reaching the peripheral continental formations (Fig. 1, 6) (Peza *et al*., 1981; 1983; Shehu *et al*., 1983; 1990; Xhomo *et al*., 2002; 2005).

In the Perlati area, on top of Kaluri radiolaritic cherts, located over andesite, are followed by breccias and radiolarites.

Gawlick *et al*., (2008) distinguished the Triassic and Jurassic radiolarites in the Perlati area, overlaying the volcanic rocks, and on top of them ophiolitic breccias. Gawlick *et al*., (2008) consider Middle Jurassic radiolarites and breccias on top located over ophiolitic mélange. They call it the Perlati formation and date them the Late Bajocian – Early Oxfordian. They show that the Triassic radiolarites (defined as of Carnian - ? Norian) overlay the Perlati volcanics.

After a long research period, study and surveys carried out in Perlati area, no Triassic radiolarites in the Perlati's volcanics was recorded. Undoubtedly, in this case, we are dealing with the Triassic radiolarite olistoliths of originating from the Porava volcano - sedimentary formation, redeposited in the Simoni mélange of Callovian - Oxfordian. Such examples can be evidenced in many regions of the Mirdita zone. The Perlati volcanic rocks belong to Middle Jurassic Age, just like all other volcanics of the Jurassic ophiolites widely documented by radiolarites in the roof and within the volcanics. Triassic volcanics belong to the volcano - sedimentary formation on the periphery, and to the basement of the Jurassic ophiolites.

The Kaluri radiolarite of Perlati volcanic roof rocks are considered by (Gawlick *et al*., 2008) to be of Late Bajocian to Early Bathonian Age, while with their stratigraphic studies their age was determined in (Prela 1996; Prela 2000) and so on, as of Bathonian - Lower Callovian (index 7 UAZ 95 Baumgartner). From this, it emerges that the "wild flysch" of the Perlati formation doesn’t belong to the Bathonian - Oxfordian, but Callovian - Oxfordian Age, which is in full compliance with the definitions of the Callovian - Oxford boundary of radiolarites, met near the Perlati mine shaft, like an interbed within the ophiolitic breccia (Kodra *et al*., 1994; 1995; Xhomo *et al*., 2002). Even the appearance of depositions in the wider areas from Konaj to the northeast of Uraka, is wrong. Deposits beneath the Cretaceous platformic limestone of the Mali i Shenjtë, do not belong to Bathonian - Oxfordian, as the authors say. They belong to the Firza flysch of Tithonian - Valanginian Age. Surprisingly, according to (Gawlick *et al*., 2008) the Firza flysch depositions for the entire Central Mirdita Zone, are represented by only some hectares near Kurbnesh (?!). In the geological map of Albania at the scale 1: 200 000 (Xhomo *et al*., 2005) are shown very clearly and more precisely Simoni mélange (depositions before closure of the Mirdita oceanic basin), compared to Firza flysch (deposits after closure of the oceanic basin).

Generally, during the Oxfordian - Kimmeridgian and Tithonian - Valanginian, in broad areas of the Mirdita zone, there was a large and deep basin where flysch and flyschoidal sediments were deposited. In the axial - eastern part of the Mirdita Zone, the synsedimentary and quasi-vertical faults (Milushi 1996), is also responsible for the presence of elevated seamount, where limestones of shallow waters were deposited (Uta 2018).

It is possible that in graben troughs, has continued sedimentation process (Shallo *et al.*, 1980; Shehu *et al.*, 1983). Generally, regarding the age of the deposit base, the oldest age is preserved in the central parts, while towards the periphery of the Mirdita zone there is a rejuvenation of the age of the deposit base. For this, it is sufficient to observe the map of the Jurassic - Cretaceous and Cretaceous deposits in Shenjti - Deja mountain range. (Xhomo *et al.*, 2005). It is evidenced that in the western and central parts, potent cretaceous limestone overlays almost transversely all the Jurassic - Cretaceous deposits of Firza flysch. In the eastern part of this range, the Jurassic - Cretaceous deposits beneath Cretaceous limestone, appear like small in size only in Krej - Lura and Kumbulla (Peza 1983; Shehu *et al.*, 1983; Xhomo, *et al.*, 2005). In the Arren - Vrri, the Cretaceous depositions are clearly rejuvenated from the centre to the east. The same thing can be said for the Cretaceous of Pashtriku - Has mountain (Xhomo *et al.*, 2005; Knoblock and Legler 2006).

The tectonic movements mainly of up and down character during the Cretaceous to Eocene, have had more local influence, and did not bring significant structural reconstructions in the Mirdita Zone. Prior to the Middle Eocene (Lutetian), researchers point out a lot of tectonic activity, which is reflected in the Middle Eocene molasse that have a wide distribution in the southern part of the Mirdita zone.

2.3.5. Late and new tectonics

It is well - known and all accepted the deformational stage of the Late Eocene - Early Oligocene, characterized by the displacement of the Mirdita Zone and the whole Inner Albanides in the outer territories of Krasta, Cukali and the Albanian Alps. The thrust plane is among the most remarkable plane in the entire Albanides structure. However, there is a lot of discussion among specialists about the size of the overthrust. The charriage was not of the same step. The front part of the Mirdita Zone has moved faster than the rest, as a result was created what Nopcsa in 1929 named "post-front depression" where in the beginning were deposited powerful molasses.

Unlike the tectonic style of deformational Jurassic stages of the closure of the Mirdita ocean basin, characterized by interoceanic and marginal bidivergent paleoemplacement, the tectonic style of the Late Eocene - Early Oligocene has only been displaced from east to west and northwest.

The Pliocene - Pleistocene faults in many instances has been extremely powerful and has influenced in the geometry of the relief.

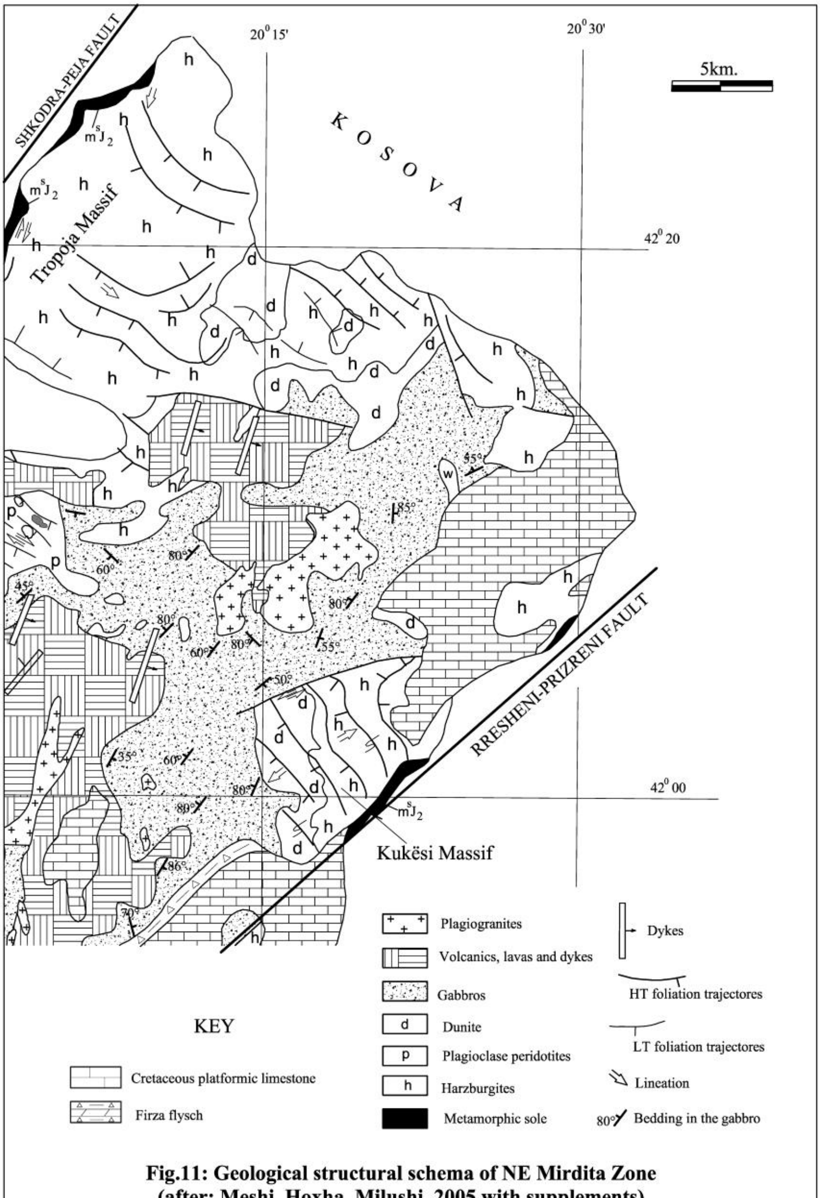


Fig.11: Geological structural schema of NE Mirdita Zone (after: Meshi, Hoxha, Milushi, 2005 with supplements)

3. CONCLUSIONS

The following conclusions could be drawn: i) Mirdita ophiolites originate in the oceanic basin at the center of the graben megastructure, between the Adria plate in the southwest, and the Korabi - Pelagonian microcontinent in the northeast, ii) the Mirdita Zone performs a "megasinclinorium" structure, consisting of two “sinclinorium” overlapping each other: a) the "sinclinorium" structure of the continental formations on the periphery and the floor of the ophiolites, b) the "sinclinorium" structure of the ophiolites with Jurassic ophiolites in the centre and the Triassic ones on the periphery and their floor. Jurassic ophiolites on the periphery consist of ultrabasic formations of mantle sequences, while in the center they are composed of gabbro - plagiogranitic plutonic massifs and oceanic crust formations, iii) the "megasinclinorium" of the Mirdita Zone is formed in two deformational stages: a) The first stages (M-1, J_2) belongs to the plunges and bidivergent interoceanic paleoemplacement of the Jurassic ophiolites onto the Triassic ophiolites and the formation of metamorphic sole among them, b) the second stage (M-2, J_2^c – J_3^{ox1}) is related to the ophiolitic bidivergent obduction onto the continental margins that marked the closure of the Mirdita oceanic basin. The tectonic style with bidivergent paleoemplacement, is a fundamental feature of Jurassic deformational stages, iv) the structure of the formations, which cover with weathering unconformity or transgression ophiolites and Triassic - Jurassic continental formations after the closure of the Mirdita oceanic basin, is slightly deformed. The tectonic style that prevailed during the Late Jurassic and Early - Cretaceous, was mainly of the horst-graben type. During Hoterivian it performed a general rise, v) the structural curvature of Mirdita Zone in its northen part is conditioned mainly by Shkodra - Peja and Rrësheni - Prizreni transversal faults, vi) during the Late Eocene - Early Oligocene, the Mirdita Zone has been overthrust over the Outer Albanides areas in the east-west direction and, vii) during the Pliocene - Quaternary, the quasi-vertical faults has had a significant influence on the morphology of the relief.

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